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BY William H. Eilberg

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FLANGE PLATES FOR FLUID PORT INTERFACES

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BACKGROUND OF THE INVENTION

The present invention relates to the field of fluid control. The invention comprises plates for attachment to an end of a fluid conduit, or for use at an interface between fluid conduits, the plates having specific structures for governing the flow of fluid.

The plates of the present invention solve various problems encountered in fluid handling. For example, it is often necessary to connect two fluid handling components together, such that fluid flows smoothly from one component to the next. At the interface between components, one must provide a seal which prevents fluid from leaking out, and which prevents contaminants from the outside from entering the fluid. The seal should be sufficiently strong that it will withstand fluid pressure in the line, but not so heavy that its cost becomes prohibitive.

Sometimes it is necessary, such as for purposes of maintenance, to block the flow through a fluid port. A plate is typically used to block off an end of a fluid conduit. The plate must be strong enough to perform the desired blocking function, but not so thick that the plate becomes unduly expensive.

Another problem solved by the present invention is the need to provide a controlled flow, through an orifice of known size, from a fluid handling component. The same considerations noted above, such as strength and cost

of the orifice plate, are relevant here. One requires an orifice plate that will withstand fluid pressure in the line, but which is not prohibitively expensive.

Various plates have been devised, in the prior art, to provide the above-described functions. Such plates typically comprise flanges which are affixed to a fluid port, or between adjoining fluid ports, the plates having various patterns formed therein. These plates are generally made according to certain standardized patterns. For hydraulic systems, a common flange pattern is SAE No. J518, although other standards have been used.

For purposes of describing the present invention, this specification will use the rectangular flange pattern according to the above-mentioned SAE standard. The present invention therefore comprises improvements over the standard plates described above. However, those knowledgeable in the art will recognize that the invention can be applied to all flange-like port interfaces, including those having multiple ports as well as those having single port connections.

SUMMARY OF THE INVENTION

In one embodiment, the present invention includes a sealing plate, intended to be sandwiched between two fluid handling components, the sealing plate having an annular seal and a structural support ring. The annular seal may be an O-ring or equivalent flexible seal, and the structural support ring is disposed within the interior region of the annular seal. The outside diameter of the support ring is preferably greater than the inside diameter of the annular seal, so that the support ring and annular

seal are held in place. This structure has the advantages that it prevents the seal from being dislodged by fluid pressure, and that it provides some structural support for valve bodies or other components that may be adjacent to the plate.

In the preferred embodiment, the structural support ring has chamfers along its outer edge, so as to provide a seat for the O-ring. The support ring may also include a plurality of orifices allowing fluid flow between the interior of the support ring and the O-ring seal.

Another embodiment of the invention includes a blanking plate which closes off a fluid conduit. The blanking plate of the present invention has a domed portion, disposed at or near the center of the plate, the domed portion being pointed towards the fluid being contained. The advantage of this structure is that it substantially increases the effective strength of the plate, making it feasible to use a relatively thin plate to contain a relatively high-pressure fluid.

Another embodiment of the invention includes an orifice plate which provides a controlled flow of fluid from one fluid component to another. The orifice plate includes a domed portion, like that of the preceding embodiment, but the domed portion has an orifice, preferably disposed at the center of the dome. This arrangement is believed to maximize the efficiency of the flow, because the highest flow velocity is found near the center of the fluid port or conduit, and the leading sharp edge orifice is less sensitive to changes in viscosity of the fluid.

In another embodiment, the invention includes a sealing plate which provides a smooth transition from one diameter to another. The sealing plate may also include additional seals disposed on the face which receives a fluid component. These embodiments make it easy to connect various fluid handling components, with maximum efficiency, even where the diameters of

all of the ports do not match.

The present invention therefore has the primary object of providing a plurality of flange plates for use with fluid port interfaces.

The invention has the further object of providing an improved seal for connection of fluid handling components.

The invention has the further object of reducing the size and cost of flange plates which provide fluid seals.

The invention has the further object of preventing dislodgment of flexible seals in fluid handling equipment.

The invention has the further object of preventing damage to valve bodies in fluid handling equipment.

The invention has the further object of reducing the size and cost of blanking plates used to block fluid flow through a port.

The invention has the further object of reducing the size and cost of orifice plates used to provide a controlled fluid flow from a port.

The invention has the further object of providing sealing plates having smooth transitions which allow fluid components having different port diameters to be efficiently connected together.

The invention has the further object of providing sealing plates which provide structural support for slip-in fluid component modules such as axial flow cartridge valves.

The reader skilled in the art will recognize other objects and advantages of the present invention, from a reading of the following brief description of the drawings, the detailed description of the invention, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1A and 1B provide front and end views, respectively, of a sealing plate of the prior art.

Figure 2A provides a front view of the sealing plate made according to the present invention.

Figure 2B provides a cross-sectional view, taken along the line 2B-2B of Figure 2A.

Figure 3A provides a fragmentary cross-sectional view of a sealing plate of the prior art, installed between two fluid ports.

Figure 3B provides a view similar to that of Figure 3A, but instead showing the sealing plate of the present invention.

Figure 4A provides a fragmentary cross-sectional view showing an O-ring seal being dislodged, when using a sealing plate of the prior art.

Figure 4B provides a fragmentary cross-sectional view showing deformation of a valve module in an arrangement of the prior art.

Figure 5A provides a front view of a preferred embodiment of the present invention, wherein the support ring has a chamfer which supports an O-ring.

Figure 5B provides a cross-sectional view, taken along the line 5B-5B in Figure 5A.

Figure 5C provides a front view of another alternative embodiment of the present invention, wherein the support ring has a plurality of orifices.

Figure 5D provides a cross-sectional view, taken along the line 5D-5D of Figure 5C.

Figure 5E provides an enlarged cross-sectional view of the embodiment of the present invention shown in Figures 5C and 5D, illustrating the rela-

tionship between the O-ring, the support ring, and the orifice.

Figures 6A and 6B provide front and end views of a blanking plate made according to the present invention.

Figures 7A and 7B provide front and end views of a plate made according to the present invention, the plate having an orifice for controlling fluid flow, and having a dome shape for strengthening the plate relative to the fluid flow.

Figures 8A and 8B provide front and cross-sectional views of another embodiment of the present invention, wherein a sealing plate provides a sealing surface and a structural support for slip-in fluid modules having ports that are smaller than the flange port size.

Figures 9A and 9B provide front and cross-sectional views of another embodiment similar to that of Figures 8A and 8B, except that the sealing plate also includes a face seal.

DETAILED DESCRIPTION OF THE INVENTION

One embodiment of the present invention includes a sealing plate which represents a substantial improvement over the prior art plate shown in Figures 1A and 1B. As shown in Figures 1A and 1B, a conventional sealing plate 1 defines an opening 3 which is intended to match an opening on a fluid conduit of a valve or other fluid handling device (not shown). The plate is attached to such device by bolts, or their equivalent, the bolts being inserted through bolt holes 4. All of the plates shown in the drawings, and described in this specification, have similar bolt holes, and are attachable to fluid handling devices in the same way.

An annular seal 5 (depicted as an O-ring) is disposed within the boundary of opening 3. In Figure 3A, the prior art sealing plate of Fig-

ures 1A and 1B is shown installed between fluid handling components 7, which may be valves, fluid conduits, or other devices.

The problems encountered with the sealing plate of Figures 1A and 1B are illustrated in Figures 4A and 4B. Figure 4A shows how the force of fluid flow, symbolized by arrows 9, can dislodge the seal 5. The result is a partial or total failure of the seal, causing the introduction of contaminants into the flow, or leaking between components.

Figure 4B shows how a valve body can become distorted when it presses against the seal. Since the plate of the prior art has no solid member within the boundary of the O-ring, there is nothing to support the valve body. One solution to the problem illustrated in Figure 4B is to make the valve body thicker and heavier, so that it is less likely to become distorted. The latter solution may be effective, but it is unduly costly.

Figures 2A and 2B illustrate an embodiment of the present invention which overcomes the above-described problems. As shown in these figures, a support ring 13 sits within the annular seal or O-ring 11 of the sealing plate 15. The diameter of the support ring is chosen such that the support ring and the annular seal are held in place. The support ring is preferably made of metal. It can also be made of other materials which are hard compared with the relatively resilient material of the O-ring.

Figure 3B illustrates the sealing plate of the present invention, as installed between two fluid handling components. The latter components are identified by reference numeral 7, the same as in Figure 3A, because the fluid handling components can be the same in both cases. Figure 3B shows the sealing plate 15 of the present invention, sandwiched between the fluid handling components. Figure 3B also shows the annular seal 11 and the support ring 13.

The support ring prevents the problems depicted in Figures 4A and 4B. In particular, by holding the O-ring in place, the O-ring is unlikely to become dislodged even under the influence of high fluid velocity in the line. Also, the support ring provides a supporting surface against which a valve or other component can bear. The support ring thus prevents a valve body, or other part of a fluid handling component, from entering the interior region of the O-ring. The support ring therefore prevents the damage shown in Figure 4B.

Figures 5A and 5B illustrate a preferred embodiment of the sealing plate of the present invention. In this embodiment, the support ring has a chamfer which centers the O-ring in its desired position. Moreover, in this embodiment, the support ring has a width which is the same as, or slightly less than, the width of the sealing plate. In the preferred embodiment, the chamfers are opposing 45° chamfers. That is, the chamfers form an angle of about 45° with respect to the axis of the support ring. In one preferred embodiment, the root where the 45° chamfers join has a nominal internal radius of 0.020 inches, to minimize stress concentration. Also, in the preferred embodiment, both outer ends of the support ring have flat portions which are at least 0.005 inches wide, to prevent the seal from being damaged. All of the latter figures are intended only as examples, and are not intended to limit the invention to any particular dimensions.

It is preferable to make the outside diameter of the support ring greater than the inside diameter of the annular seal, to prevent the components from coming apart during handling. This geometry also insures that the annular seal will fit within the cavity defined by the sealing plate and the support ring.

The centering chamfer aids in positioning the support ring in the

center of the annular seal (O-ring). The chamfer also makes it easier to supply the sealing plate and the O-ring as an assembly together with the support ring. During pre-loading of the O-ring, the support ring assists in directing the displacement of the O-ring towards the joints that are being sealed.

An alternative embodiment of the invention is shown in Figures 5C and 5D. In this embodiment, the support ring includes orifices 17 which direct the flow of fluid from a pressurized port to the center underside of the annular seal. This arrangement insures that the fluid loading of the seal is outward, toward the joints that are being sealed. When the system pressure is reduced, fluid decompression is permitted through these orifices.

The embodiments of Figures 5A-5D are summarized in the enlarged view of Figure 5E. Figure 5E shows sealing plate 19 having annular seal (O-ring) 21, and structural support ring 23. The orifice 17 in the support ring is clearly visible. Figure 5E also shows chamfered surfaces 25, and flat outer ends 27. Note also that in Figure 5E, the outside diameter of the support ring is larger than the inside diameter of the O-ring; this feature tends to hold these parts together.

Figures 6A and 6B illustrate another embodiment of the invention. This embodiment comprises a blanking plate, which is used to block the flow of fluid up to the maximum pressure rating in the line. Blanking plate 29 is shown with dotted line 31 which indicates the diameter of the port to be blocked. The end view of Figure 6B shows dome 33, formed integrally with the plate. The dome faces the fluid side that is to be blocked and pressurized. In other words, the dome is convex on the side that contacts the fluid. The dome provides a smooth transition from the flat surface of the plate to the apex of the dome, at or near the center of the plate.

The dome permits the relatively thin plate to withstand a higher pressure, without damage, than would be possible with a flat blanking plate made of the same material and having the same thickness. Use of the dome therefore achieves a reduction in weight and cost, because one can use a relatively thin plate and still provide sufficient strength to withstand the pressurized fluid.

Figures 7A and 7B depict another embodiment of the present invention. These figures show orifice plate 35, which is used to control the flow in a fluid line by allowing the fluid to escape through an orifice of known diameter. As in Figure 6A, dotted line 37 indicates the diameter of the fluid port against which the orifice plate sits. The plate includes an orifice 43, the position of the orifice being indicated by circle 39 in Figure 7A. As in the embodiment of Figures 6A and 6B, the plate includes a smoothly curved dome 41, which enables the plate to withstand relatively high fluid pressures in the line. The dome is intended to be oriented facing the side from which flow is to be controlled.

As shown in Figure 7B, the orifice is positioned at the center of the dome. This arrangement insures that the orifice comprises a leading sharp edge orifice in the center of the flow conduit, making the orifice relatively insensitive to changes in the viscosity of the fluid. Efficiency is believed to be maximized because the highest flow velocity is found near the center of the fluid conduit, i.e. at the center of the plate, and the leading sharp edge orifice is less sensitive to changes in fluid viscosity. Also, the use of the domed structure saves weight and reduces cost, for the same reasons given with respect to the embodiment of Figures 6A and 6B.

Another embodiment of the invention comprises a plate which provides both sealing and structural support for slip-in fluid modules, such as valves, filters, etc., and which also works with modules having port sizes

different from the flange port size. The term "slip-in", as used herein, means that the component slides into a cavity in an appropriate block or flange body or other holding means, rather than being screwed in. An example of a fluid component with which this embodiment can be used is an axial flow cartridge valve. The cartridge slides into a cavity in a block, the cavity being sized to accommodate the cartridge.

Figures 8A and 8B provide an example of a sealing plate used with a slip-in valve module. The slip-in valve module 55 has an inside diameter, symbolically indicated on the right-hand side of Figure 8B, the inside diameter of the valve module being significantly smaller than the inside diameter of the port, indicated at the left-hand side of the drawing. Seal plate 45 includes outer bore 47, which provides a smooth transition to inner bore 49. The seal plate abuts fluid flange body 51. Due to its reduced diameter opening, the seal plate provides structural support as well as a sealing surface for the slip-in valve module. The diameter of the inner bore of the seal plate is smaller than the diameter of the seals associated with the fluid component.

The seal plate 45 shown in Figure 8B is relatively thick. The seal plate should be sufficiently thick to provide adequate support for the valve module, especially in the event of a pressure failure in the line. For example, if the pressure drops abruptly on the left-hand side of Figure 8B, the seal plate will be urged to the left, due to the fluid pressure in the valve. If the seal plate is too thin, it may not withstand the fluid pressure, and will bow outward, to the left, allowing the valve module to shift to the left and to become damaged.

Figures 9A and 9B provide illustrations of an alternative to Figures 8A and 8B, wherein the sealing plate contains an additional face seal 53.

This face seal is shown on only one side of the plate, but it can be provided on either or both sides. As in the preceding embodiment, the sealing plate includes a transition bore to improve flow characteristics.

The embodiments of Figures 8A, 8B, 9A, and 9B therefore permit the use of slip-in valve modules, or other modules, that are smaller than the nominal line size, making it possible to provide the necessary components, having the desired performance characteristics, at reduced cost.

All of the plates described in this specification can be made of various materials, depending on the particular application. In standard petroleum-based hydraulic systems, steel is normally the preferred material for these plates.

The invention can be modified in many ways. The particular structure of the plates can be varied. The number of bolt holes, for example, can be changed. The number of ports accommodated in a single plate can be varied. The shape of the ports can change; the invention is not limited to ports having a circular cross-section. Many of the features of the invention, discussed above, can be combined in the same plate. These and other modifications, which will be apparent to those skilled in the art, should be considered within the spirit and scope of the following claims.